

DRILLING HAMMER

Background Information

The present invention is directed to a drilling hammer according to the definition of the species of Claim 1.

It is commonplace today to equip drilling hammers having a certain rating such that they can be used in the "impact or hammer drilling" operating mode, in which the striking tool hammers the work piece in the axial direction while the tool is simultaneously started rotating using the tool holder, and they can be used in the "chiseling" operating mode, in which only the striking tool is activated and the rotational drive for the tool holder is turned off. Since a single electric motor drives, via a gear unit, a hammer tube that is connected with the tool holder in a torsion-proof manner, and it drives the striking tool via a crank driving mechanism, the piston of which makes a reciprocating stroking motion in the hammer tube and acts on a beater which, in turn, transfers the impacts to the end of the tool via a snap die, an operating mode change-over switch is provided that separates the hammer tube from the gear unit in the "chiseling" operating mode and secures it against rotation in the housing. In this mode, the rotatably supported driven gear of the gear unit encompassing the hammer tube is separated from the hammer tube.

Advantages of the Invention

The drilling hammer according to the present invention having the features of Claim 1 has the advantage that the switching mechanism of the operating mode change-over switch is very flat in design and the axial extension of the operating mode change-over switch can be kept small due in particular to a narrow actuator ring. The flat design allows the housing cover on which the manually operated control button is mounted to have a low profile and the width across

corners of the drilling hammer, i.e., the distance between the center of the switching mechanism and the upper edge of the housing, to be kept small. A single locking spline is sufficient to establish a torsion-proof connection between the actuator ring fixed on the hammer tube in a torsion-proof and axially displaceable manner and the driven wheel of the gear unit. Preferably, a large number of locking splines distributed around the circumference of the actuator ring is provided, the locking splines being axially insertable into a correspondingly large number of axial recesses in the driven wheel. As a result of the large number of locking splines and axial recesses, the actuator ring—which is made of metal—can transfer higher torque, and may also be made of plastic. In addition, given the non-aligning orientation of locking splines and axial recesses, a very small path of rotation of the hammer tube is required to snap the actuator ring into the drive wheel. If the guide splines on the actuator ring provided for a torsion-proof connection and guide grooves in the hammer tube are equidistant, the actuator ring can be slid onto the hammer tube in any relative position, which makes installation easier. The switching mechanism can be designed to be very compact and stable despite the small overall size, thereby ensuring a long service interval.

Advantageous further developments and improvements of the drilling hammer indicated in Claim 1 are possible due to the measures listed in the further claims.

According to an advantageous embodiment of the present invention, the actuator ring is located on the side of the driven wheel facing away from the control button and is connected in a fixed manner—underneath the drive wheel and past it—with a coupling ring slid onto the hammer tube on the other side of the driven wheel, the coupling ring being coupled to the control button such that switching the control button brings about an axial displacement of the actuator ring. Due to this structural design, the switching mechanism on the hammer tube is located under the driven wheel of the gear unit so that the width across corners of the

drilling hammer is determined only by the outer diameter of the driven wheel—
which is typically designed as a ring gear—and is minimized by it.

According to an advantageous embodiment of the present invention, the
connection with the coupling ring, which is preferably made of plastic, is realized
using two cantilevers, which extend integrally with the coupling ring axially away
from said coupling ring and accommodate the actuator ring in recesses located
near its ends. The actuator ring can be installed easily by pressing the two
elastically outwardly preloaded cantilevers together. The circumferential play of
the cantilevers is kept greater than that of the actuator ring on the hammer tube,
so that the cantilevers need not transfer any torque.

According to an advantageous embodiment of the present invention, the coupling
ring is coupled to the control button via a shift fork that is guided with a projection
in an annular groove in the coupling ring, whereby the coupling takes place via a
synchronizing spring retained on the shift fork and an eccentric pin located on the
control button, on which said eccentric pin the legs of the shifter fork bear in a
non-positive manner at diametral points. The large synchronizing spring allows
the operating mode change-over switch to be changed over easily and reliably.
The shift fork and the coupling ring can be fabricated economically out of plastic.
The size of the control button makes operation easier and also permits handling
using work gloves.

According to an advantageous embodiment of the present invention, a further
setting position for the “drilling” operating mode is assigned to the control button;
in this mode, the striking tool is decoupled from its drive when the hammer tube
rotates. This decoupling is not brought about by the axial displacement of the
actuator ring on the hammer tube, but rather by the displacement—at a right
angle thereto—of a switching mechanism part that separates a coupling located
in the drive chain of the striking tool. To this end, a switching ramp which extends
across an angle of rotation is configured on the control button, preferably on its

underside, the switching ramp rising in the direction of the axis of rotation of the control button. The switching mechanism part is preferably configured as an axially displaceable separating slide, which bears against the switching ramp in a non-positive manner and against a displaceable coupling part of the coupling that, when displaced axially against the force of a coupling spring, the coupling can be released. The low spring force of the coupling spring and a spring provided on the separating slide for bearing against the switching ramp in a non-positive manner permits the operating mode change-over switch to be operated in an easy yet reliable manner.

Drawing

The present invention is explained in greater detail in the description below with reference to an exemplary embodiment presented in the drawing.

Figure 1 shows, in sections, a longitudinal sectional view of a drilling hammer with an operating mode change-over switch,

Figure 2 shows a perspective drawing of a switching element of the operating mode change-over switch in Figure 1,

Figure 3 shows the switching element according to Figure 2, in a perspective drawing, the switching element having been partially extracted from a hammer tube of the drilling hammer,

Figure 4 shows a top view of a control button of the operating mode change-over switch in Figure 1,

Figures 5 through 8 show a top view of a control button lower part and a coupled shift fork of the operating mode change-over switch in Figure 1 in four different setting positions of the control button,

Figure 9 shows a profile of the control button lower part with switching ramp for actuating a vertical separating slide of the operating mode change-over switch in Figure 1.

Detailed Description of the Embodiments

The drilling hammer shown in a sectional view in Figure 1 with its rear region in a longitudinal sectional view includes a housing 10 with a housing opening 11 that is closed by a housing cover 12. A tool holder extends out of housing 10 at its left end, which is not shown in Figure 1, on which a tool is mounted in a limited axially displaceable manner. The tool holder is connected in a torsion-proof manner with a hammer tube 13 rotatably supported in housing 10. An air cushion striking tool 14 with a piston 15 capable of being displaced axially in hammer tube 13 is located in hammer tube; the air cushion striking tool can be brought into reciprocating motion using a crank driving mechanism 16 located in a drive chain between an electric motor 27 and piston 15. Air cushion striking tool 14 further includes a beater driven by piston 15, the beater acting via a snap die on the end of the tool mounted in the tool holder. To this extent, the drilling hammer described here conforms with the drilling hammer described in DE 38 26 213 A1, whereby the arrangement and configuration of the tool holder, hammer tube 13 and air cushion striking tool 14 with piston 15 described there also apply to the drilling hammer described here.

Crank driving mechanism 16 includes a crank wheel 18 with an integral bearing tube 181 and a crank pin 19 positioned eccentrically to the axis of rotation, on which a push rod 20 bears in a rotatable manner, the push rod being connected with piston 15 of air cushion striking tool 14 in a swivelling manner. Crank wheel 18 is supported in a rotational manner with its bearing tube 181 on an axis 17 in the housing. A gear wheel 21 with external teeth 22 is situated on bearing tube 181 in a rotatable and axially displaceable manner. A coupling spring 23

1 configured as a coil compression spring bears between crank wheel 18 and gear
2 wheel 21, the coupling spring pressing gear wheel 21 on the front side against a
3 separating slide 24 described in detail hereinbelow. In this displacement position
4 of gear wheel 21 shown in Figure 1, a torsion-proof connection between crank
5 wheel 18 and gear wheel 21 is established via a tooth system 25 between gear
6 wheel 21 and bearing tube 181 of crank wheel 18; the torsion-proof connection
7 can be released by sliding gear wheel 21 in Figure 1 upward. A coupling is
8 therefore located in the drive chain, one coupling part of which is formed by crank
9 wheel 18 with bearing tube 181; the other coupling part, which can be actuated
10 by separating lever 24, is formed by gear wheel 21. The coupling is held closed
11 by coupling spring 23. Gear wheel 21 meshes with its outer teeth 22 in a drive
12 pinion 28 formed on a driven shaft 26 of electric motor 27. It should be noted
13 that, in Figure 1, crank driving mechanism 16 is shown in a position in which
14 piston 15 assumes its anterior dead-center position, shown at the left in Figure 1.
15 To ensure clarity in the drawing, piston 15 is shown further to the left than it
16 would be under actual circumstances, however.

17
18 Hammer tube 13, which is rotatably supported in housing 10, is started rotating
19 by electric motor 27 via a gear unit 30, so that the tool, which is axially
20 displaceable with limitation in the tool holder and is mounted in a non-rotative
21 manner, also rotates. Gear unit 30 includes a ring gear located on hammer tube
22 13, the ring gear being retained on hammer tube 13 in an axially displaceable
23 and rotatable manner, a bevel gear 32 meshing with teeth on ring gear 31, and a
24 gear wheel 33 with external teeth 34 that is connected with bevel gear 32 in
25 torsion-proof fashion. Bevel gear 32 and gear wheel 33 are rotatably retained in
26 housing 10, and external teeth 34 mesh with drive pinion 28 on driven shaft 26 of
27 electric motor 27.

28
29 The drilling hammer described in this manner can be used in three operating
30 modes. In the "impact drilling" operating mode, electric motor 27, which has been
31 turned on, brings hammer tube 13 into rotation and activates air cushion striking

tool 14; for this purpose, the coupling in the drive chain of air cushion striking tool 14 (as shown in Figure 1) is closed and ring gear 31 is connected with hammer tube 13 in a torsion-proof manner. In the "chiseling" operating mode, only the air cushion striking tool 14 is activated; for this purpose, the coupling in the drive chain of air cushion striking tool 14 is closed and ring gear 31 is decoupled from hammer tube 13. In the "drilling" operating mode, air cushion striking tool 14 is idled and hammer tube 13 is started rotating; for this purpose, the coupling in the drive chain of air cushion striking tool 14 is opened and ring gear 31 is connected with hammer tube 13 in a torsion-proof manner.

An operating mode change-over switch 35 serves to set these three different operating modes of the drilling hammer, the operating mode change-over switch including a single, manually operated control button 36 and a switching mechanism 37 having a stable and compact design. Control button 36 is located in housing cover 12 such that it is protected and user-friendly. It includes a control button lower part 38 and a control button cap 39 that overlaps a collar 121 formed on housing cover 12. Control button lower part 38 is inserted in a multi-step bore encompassed by collar 21 and secured to the underside of control button cap 39. Control button lower part 38 includes an eccentric pin 40 that extends at a right angle from the underside of control button lower part 38, and a switching ramp 41 that is located on the underside of control button lower part 38, extends in the circumferential direction of control button lower part 38, thereby rising in the direction of the rotational axis of control button 36, i.e., downward in Figure 1.

Switching mechanism 37 also includes separating slide 24 mentioned above; the separating slide is guided in housing 10 in a vertically displaceable manner and bears with a U-bent slide end 241 on the underside of control button lower part 38 or switching ramp 41, and, with its other U-bent slide end 242, it overlaps gear wheel 21 that forms the displaceable coupling part of the coupling in the drive chain of air cushion striking tool 14. Upper slide end 241 is pressed by a spring

41 shown only schematically in Figure 1 against the underside of control button lower part 38 and/or against switching ramp 41, whereby the spring force of spring 42 is greater than the spring force of coupling spring 23, so that, in the range of rotation of control button lower part 38 in which upper slide end 241 leaves switching ramp 41, gear wheel 21 is slid upwardly by spring 42 and lower lever end 242—while tensioning coupling spring 23 in Figure 1—so far that toothed connection 25 between crank wheel 18 and gear wheel 21 is released, the coupling in the drive chain of air cushion striking tool 14 is therefore opened and striking tool 14 is turned off. As illustrated in the profile of switching ramp 41 in Figure 9, the switching ramp extends across an approximately 270° circumferential angle of control button lower part 38, so that separating slide 24 is released to be displaced by spring 42 only in a range of rotation of approximately 90° of control button 36.

Switching mechanism 37 also includes a switching element 43 slid onto hammer tube 13, which is shown in a perspective drawing in Figures 2 and 3, and a shift fork 44 that connects switching element 43 to control button 36. Switching element 43 is composed of a coupling ring 45 made of plastic, from which two diametrically located cantilevers 46 integral with coupling ring 45 extend axially. Each cantilever 46 is provided with a recess 47 on its free end opposite the ring and are pretensioned outwardly in the radial direction of coupling ring 45. When the two cantilevers 46 are pressed together, an actuator ring 48 can be inserted into recesses 47, the actuator ring being composed preferably of metal. On its inside facing hammer tube 13, actuator ring 48 includes two diametrically located, radially projecting guide splines 49 that are positioned in corresponding guide grooves 50 recessed in the outside of hammer tube 13. Two further guide grooves 50 are recessed in hammer tube 13, each of which accommodates one of the two cantilevers 46. The dimensions of cantilevers 46 and guide splines 49 are preferably the same, so that all four guide grooves 50 can be configured identically. On its outside facing away from hammer tube 13, actuator ring 45 includes a plurality of equidistantly spaced, radially projecting locking splines 51

that are configured such that they can be inserted axially in corresponding axial recesses 52 on the underside of ring gear 31 facing hammer tube 13. A locking part 53 in the housing is diametrically opposed to the insertion openings of axial recesses 52 in ring gear 31, the locking teeth of which are configured such that locking splines 51 can be inserted axially into locking part 53 and can be positioned in a form-locked manner in the direction of rotation. Locking part 53 is located with axial clearance from axial recesses 52 in ring gear 31 such that, once actuator ring 48 slides out of ring gear 31, actuator ring 48 can still assume a position in which its locking splines 51 do not yet engage in locking part 53. In this "neutral" or "zero" position of actuator ring 48, hammer tube 13 is not coupled to ring gear 31 or locking part 53 in the housing, enabling hammer tube 13 to rotate freely. Coupling ring 45 includes a recess or an annular groove 54 into which a radially directed projection 45 of shift fork 44 engages.

Flat shift fork 44, which is shown in a sectional view in Figure 1 and a top view in Figures 5 through 8 and is preferably made of plastic, extends with its free end on which the projection is located over hammer tube 13 to annular groove 54 in coupling ring 45; it turns downward at the end of hammer tube 13 and extends underneath control button lower part 38. The coupling of shift fork 44 to control button 36 takes place via a synchronizing spring 56 and eccentric pin 40 on control button lower part 38. Synchronizing spring 56 is configured as a coil spring with long legs 561, 562 U-bent at a right angle to the spring axis, the spring being slid onto a bolt 57 projecting upward at a right angle from shift fork 44 and bearing with its two long legs 561 and 562 on diametral points of eccentric pin 40 in a non-positive manner, the points nearly aligning with each other in the sliding direction of shift fork 44 (Figures 5 through 8). Eccentric pin 40 is located on control button lower part 38 at an angle α relative to the longitudinal axis of shift fork 44 such that, when control button 36 rotates by 90° , four rotated positions of eccentric pin 40 result, each being offset from the other by a distance $a/2$ as viewed in the sliding direction of shift fork 44, as shown in Figure 5. The overall displacement travel of shift fork 44 is a , after which shift fork

44 bears against a stop 59 in the housing. The upper slide end 241 of separating slide 24 is shown in the illustrations in Figures 5 through 8, the slide end extending past the underside of control button lower part 38 and bearing on switching ramp 41 across a circumferential angle of nearly 270°.

Control button cap 39 is shown in a top view in Figure 4. It includes a gripping segment 58 on which a marking tip 581 is configured. Marking tip 581 indicates the setting position of control button 36, that is, the "chiseling" mode (M), the "impact drilling" mode (S), and the "drilling" mode (B), which are set by operating mode change-over switch 35. In addition, a "neutral" or "zero" position (0) is provided, in which only the air cushion striking tool 14 is active but not the rotary drive for hammer tube 13, and hammer tube 13 can rotate freely and at random in housing 10.

The mode of operation of operating mode change-over switch 35 is as follows:

If control button 36 is set, as shown in Figure 4, such that marking tip 581 points to position M, shift fork 44 is displaced furthest to the left in Figure 1 along the maximum displacement travel a, as shown in Figure 5. Accordingly, switching element 43 is displaced by shift fork 44 as far to the left as possible; as a result, actuator ring 48 with its locking splines 51 is pressed into locking part 53 in the housing. Hammer tube 13 is fixed in housing 10 in a torsion-proof manner by the torsion-proof connection of actuator ring 48 with hammer tube 13 via guide splines 49, cantilevers 46 and guide grooves 50, and there is no connection between hammer tube 13 and ring gear 31. When electric motor 27 is turned on, freely rotating ring gear 31 and air cushion striking tool 14 are driven by gear unit 30, since separating slide 24 bears with its upper slide end 241 on switching ramp 41 and, as shown in Figure 1, is displaced downward so that coupling spring 23 holds the coupling between crank wheel 18 and gear wheel 21 closed. Since only air cushion striker train 14 is activated, the tool is driven only by air cushion striker train 14 with an axial striking motion.

1 If control button 36 is turned out of position M into position 0 by 90° in Figure 4 in
2 the counter-clockwise direction, shift fork 44 is displaced by eccentric pin 40 and
3 synchronizing spring 56—as shown in Figure 6—to the right along displacement
4 travel $a/2$ in Figure 1. Switching member 43 in Figure 1 is displaced to the right
5 along the same displacement path by coupling ring 45; as a result, locking
6 splines 51 on actuator ring 48 disengage from locking part 53, and actuator ring
7 48—as shown in Figure 1—assumes a central position between locking part 53
8 and ring gear 21. Hammer tube 13 is released to rotate freely, but is not started
9 rotating by electric motor 27. Air cushion striking tool 14 remains activated, since
10 separating slide 24 is also held in this rotational position of control button 36 by
11 switching ramp 41 in the position shown in Figure 1.

12
13 If control button 36 is turned to control button position SB, shift fork 44 is
14 displaced to the right along displacement path $a/2$ in Figure 1 and, after eccentric
15 pin 40 covers half of the rotation path, it contacts stop 59 in the housing.
16 Eccentric pin 40, which moves further, deflects spring leg 561 of synchronizing
17 spring 56 (Figure 7). Shift fork 44, which is being displaced by the distance $a/2$,
18 pushes actuator ring 48 in Figure 1 so far to the right that locking splines 51 slide
19 into axial recesses 52 in ring gear 31 in a form-locked manner and therefore
20 connect hammer tube 13 to ring gear 31 in a torsion-proof manner. Electric motor
21 27 now brings hammer tube 13 and, therefore, the tool holder and the tool
22 retained in the tool holder in a torsion-proof manner into rotation. Air cushion
23 striking tool 14 remains activated, since upper slide end 241 of separating slide
24 24 has not yet left switching ramp 41 (refer to position SB in Figure 9).

25
26 If control button 36 is now turned further by 90° into setting position B, eccentric
27 pin 40 returns along rotation distance $a/2$. Since eccentric pin 40 in setting
28 position SB had previously moved rotation distance a (Figure 7) given a
29 displacement travel of shift fork 44 by $a/2$ while deflecting spring leg 561, this
30 return of eccentric pin 40 does not cause shift fork 44 to become displaced.
31 Actuator ring 48 therefore retains its engaged position in ring gear 31. As a result

1 of the rotation of control button lower part 38 around this further 90°, switching
2 ramp 41 has slid out of the region of the upper lever end 241 of separating slide
3 24, so that separating slide 24 is pushed upward by spring 42 in Figure 1 until it
4 bears against the switching ramp-free region of control button lower part 38 and,
5 thereby, its lower lever end 242 pushes gear wheel 21 upward while pressing
6 coupling spring 23 together, so that the external teeth between gear wheel 21
7 and bearing tube 181 of crank wheel 18 become disengaged and the coupling in
8 the drive chain of air cushion striking tool 14 is opened. Air cushion striking tool
9 14 is therefore decoupled from electric motor 27 and, finally, hammer tube 13 is
10 started rotating by electric motor 27. Pure drilling work can now be carried out
11 with the tool retained in the tool holder in a torsion-proof manner.

12
13 It is possible, of course, to turn control button 36 out of its setting position M in
14 the opposite direction of rotation directly into setting position B and then, from
15 here, further to setting position SB and then 0. Nothing about the mode of
16 operation of switching mechanism 37 changes as a result.

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